PATENT SPECIFICATION

DRAWINGS ATTACHED

864,443

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Tire molding apparatus.

COMPLETE SPECIFICATION

We, THE FIRESTONE TIRE & RUBBER COMPANY, a corporation organized under the laws of the State of Ohio, United States of America, of 1200 Firestone Parkway, Akron 17, State of Ohio, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to means for vulcanizing pneumatic tires, and more particularly to means for accurately molding and vulcanizing a pneumatic tire in a mold without an internal shaping element.

Before the present invention, one method of shaping and vulcanizing a pneumatic tire was by working it from the flat band shape to the toroidal shape around a toroidal rubber bag inserted in the tire. The tire and the bag about which it was shaped were inserted in a vulcanizing mold where heat was applied to the outer surface of the tire, and a hot fluid such as air, steam or superheated water was injected under pressure into the rubber bag to force the tire outwardly against the hot mold to compact and vulcanize the rubber into final shape.

A recent advance in tire manufacturing technology has been the use of a bladder-inserting type vulcanization press, wherein the unvulcanized tire band is formed in the shape of a torus in the mold in which it is to be vulcanized by inflation of an expanding bladder inside the tire as the mold is closed.

A disadvantage of the prior art method of shaping and vulcanizing tires resided in the fact that the rubber bag or bladder would deteriorate after repeated cures and had to be replaced. Also, the walls of such forming members presented a barrier to the transfer of heat, so that much of the heat from the fluid put into the member was used up in heating the member itself before the tire could be heated to vulcanization temperature. Accordingly, it has been suggested to do away with the forming member in the vulcanization of tires, such as tubeless tires, having fluid impervious liners across the inside surface, and to apply the hot fluid directly against the inner wall surface of the tire. This suggestion had proved impractical, because in the absence of the wall of the inner forming member there was insufficient positive pressure exterted against the inside surface of the tire to compact and mold the beads to the desired shape. Also care must be taken not to apply too much pressure to the beads during formation of the tire since rotation of the beads is necessary to relieve tension on the fabric plies as the tire is expanded from the flat band shape to the toroidal shape as the mold is closed.

The present invention overcomes the difficulties of the prior art through use of radially expanding bead molding rings, in combination with two relatively movable tire mold sections to provide positive pressure for molding the bead of a tire cured without the prior art curing bag or bladder.

It is therefore an object of the invention to provide means for vulcanizing a pneumatic tire using a hot fluid applied under pressure directly against the inner wall surface of the tire. A further object of the invention is to provide radially extensible means for accurately and uniformly molding the contour of the bead surface during vulcanization of the tire. Yet another object of the invention is to provide a method of forming and vulcanizing a tire without an internal forming member which includes application of positive pressure of varying degrees in timed relation to the closing of the mold sections in which the tire is cured.

Yet another object of the invention is to provide internal bead molding rings which may be radially collapsed and expanded as

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well as separated axially to apply pressure to the tire bead in timed relation to the operation of a tire vulcanizing mold.

According to the present invention there is provided apparatus for molding and vulcanizing a vehicle tire comprising at least two relatively movable mold sections forming a tire defining cavity, radially expansible and contractable tire bead molding means spaced between said mold sections for clamping the beads of the tire against the bead molding surfaces of the mold sections, means to radially expand said bead molding means to bring them into contact with the inner bead surfaces of the tire, and for moving them axially with respect to and in timed relation with the movement of said relatively movable mold sections, said bead molding means comprising upper and lower segmented bead clamping rings, the segments of which are radially expansible and contractable in the same horizontal plane.

These and other objects of the invention will be more easily understood with reference to the specification, claims and drawings of which:

Fig. 1 is a side elevation, partially broken away and in section, of a tire mold incorporating the invention.

Figs. 2-6 are somewhat diagrammatic sectional views of the rings, molds and related parts, showing the sequence of operation of shaping and vulacnizing a tire in view of the invention.

Fig. 7 is an enlarged fragmentary sectional view of the mechanism of the lower bead forming rings of the invention.

Fig. 8 is a plan view taken on line 8—8 of Fig. 1 of the top ring of the invention showing the organization of parts when the ring is closed.

Fig. 9 is a plan view of the top ring of the invention showing the organization of parts when the ring is extended to molding position.

Referring to Fig. 1, a tire vulcanizing press is comprised of a lower platen 1 cooperating with an upper platen 2, mounting respectively tire mold sections 4 and 3 having partial tire defining cavities which form, when the mold is closed and the sections abut, a cavity in which a tire is vulcanized. Lower platen 1 is mounted on base 5 which stands on the floor or other suitable support, and that platen, as well as upper platen 2 is chambered for circulation of steam in the conventional manner. Upper mold section 3 is mounted by suitable means to head or dome 7 which is pierced by a bolt 6 on which are pivoted pressure links 9. A similar bolt and pressure link arrangement is mounted on the other side of the mold but is not shown. Also pivoted on each side of dome 7 are two guide plates one of which is shown at 11. Pressure link 9 is pivoted by gear wheel 10 through suitable means, not shown, and not part of the invention. Rotation of gear wheel 10 and a corresponding gear wheel, not shown, on the other side of the mold activates the pressure links first to raise the dome with platen 2 and upper mold section 3 vertically from lower mold section 4, and then to rock dome 7 with platen 2 and mold section 3 back to the position shown in phantom outline in Fig. 1.

When, as in the prior art, the mold press (Fig. 1) is used with an internal bladder to vulcanize a tire, the tire band is positioned in the press coaxially with and around a barrel-shaped bladder (not shown). The upper mold section 3 is lowered onto the lower mold section 4, as gear wheel 10 rotates to manipulate link 9. The bladder inside th etire is expanded in the tire as the mold closes, whereupon hot fluid under pressure is intrdouced into the diaphragm and the tire is molded into the toroidal form. The foregoing organization of structure is old in the art. In the present invention, as shown in the figures, the inner diaphragm is not used, and the fluid pressupre is exerted directly against the inside wall surface of the tire instead of against the inside wall surface of the bladder.

In view of the invention, and referring to Figs. 1 to 8 an upper bead molding ring 15 and a lower bead molding ring 14 are adapted for radial expansion inside the tire in timed relation to the various steps in the tire shaping and vulcanizing operation. The lower molding ring 14 also is mounted for vertical movement on piston rod housing 16 in response to pressure cylinder 22. The ring is radially expanded and contracted by rotation of the ring in response to rack 20 activated by piston 22′. Cylinder 22′ and rack 20 are mounted on a plate 71 for vertical movement in response to the action of cylinder 22, and as the piston rod housing 16 moves axially with respect to the tire, the complete unit, including cylinder 22′, rack 20 and the pinion 18, move axially with the piston rod. This action makes it possible for the ring 14 to be radially expanded or contracted at various axial positions with respect to the tire.

In a like manner, upper bead ring 15 is mounted on piston rod housing 17 actuated by piston 23. The ring is adapted for radial expansion and contraction by rotation of pinion 19 by cylinder 23′ manipulating rack 21. Upper molding bead ring 15 is axially positioned and radially expanded and contracted in timed relation with the tire shaping and vulcanizing operation.

Referring to Fig. 8 a plan view of lower bead forming ring 14 shows the ring comprised of five segments 27 mounted on hub

34 by arms 28. Arms 28 are integral with segments 27, but are pivoted on hub 34 at 31. The arms are adapted for controlled pivoting movement with respect to hub 34 by links 29, which have one end pivoted as at 32 on a second hub 35 and the other end pivoted at 30 on the arm 28.

Hub 34 is mounted on an inner tube-shaped member 36 merging with and connected to pinion 18 and adapted to be rotated by the action of that pinion. The second hub 35 is secured to outer casing 16 and axially slidably mounted with respect to lower platen 1. Arms 28 are pivoted at 31 on hub 34 but through linkage 29 pivoted at 32 they are also anchored to hub 35. Linkage 29 is pivoted at 32 on hub 35 as well as at 30 on arm 28. It will be seen that the hub 35 is not adapted for rotation while hub 34 is adapted for rotation. Rotation of hub 34 moves arms 28 about pivots 31 to extend or contract arms 27 in the radial direction.

To open the collapsible ring to the molding position the ring shown in Fig. 8 is rotated in a counter clockwise direction to extend arm 28 and links 29 radially to the position shown in Fig. 9. When the ring is collapsed the hub 34 is rotated in a clock wise direction thereby retracting segments 27.

In order that the expansion of the tire and the pressure used internal of the tire may be increased and decreased in timed relation to the movement of the mold sections axially with respect to the tire as well as in timed relation to the pressure exerted on the bead rings against the tire bead, a system of electric and fluid pressure controls is necessary. Fig. 3 shows schematically the electrical and fluid pressure systems and controls of the invention. To provide for actuation of the tire forming and vulcanizing cycle a motor control button 49 is located on the press. By pushing this button, the operator actuates a motor control of a conventional type to start the motion of the upper mold section and its platen 7 in an axial downward direction towards the lower mold section 4 (Fig. 1). As the upper mold section 3 descends a cam 48 consecutively contacts limit switch 50, 51 and 52, to actuate, respectively, through electrical connections of the conventional type not shown, pressure valves 53, 54, 56 and 57.

It is to be understood that cam 48 is shown schematically for purposes of clarity of description and that in actual arrangement the cam or its equivalent would preferably be arranged at a position remote from platen 2. For example the cam may be an element in a standard timer which actuates a number of circuits in timed sequence with the closing and opening of the mold. Such timers and controls are well known to those skilled in the art of tire and tire mold manufacture.

Valves 53 and 54 activate upper and lower cylinders 23 and 22 through 4-way solenoid valves 60 and 61 respectively and thereby make the action of those cylinders responsive to the position of the upper mold section 3. Valves 58 and 59 are also 4-way solenoid valves, which activate cylinders 23' and 22'. These valves respond to the timing circuit represented by switches 50, 51 and 52, to radially expand and contract and axially position rings 14 and 15 with respect to relative positions of the mold sections.

In operation of the invention a tire band 24, having beads 40 and 41, is centered in the press coaxially with lower mold section 4 (Fig. 2). The upper mold section 3 on platen 7 is in the open position drawn back from the mold as shown in phantom in Fig. 1. The operator presses motor control button 49, to initiate the power drive of the system to rotate gear wheel 10. Upper mold section 3 and platen 7 swing forward as pressure links 9 pivot with gear wheel 10 until upper mold section 3 reaches the position shown in full line in Fig. 1 coaxial with lower mold section 4 and tire band 24. At this position cam 48 on platen 7 trips switch 50 to energize valve 53 of low pressure fluid supply whereby cylinders 22 and 23 are activated through solenoid valves 60 and 61 to extend casings 16 and 17, respectively. Axial extension of these casings positions the upper and lower molding rings 15 and 14 in spaced axial relation adjacent the crown of the tire band, as shown in Fig. 3.

Upper mold section 3 continues axial descent until the bead defining portions of the mold cavity contact the upper beads 40 of the tire, at which position cam 48 trips limit switch 51, energizing valve 70 and solenoid valves 58 and 59, respectively, which in turn actuate cylinders 22' and 23', to extend racks 20 and 21 to rotate pinions 18 and 19, respectively. This action rotates the upper and lower molding rings about their central axis, to bring them into the open position shown in Fig. 4 wherein they rest positively but lightly against the inner surface of the bead of the tire. Simultaneously, limit switch 51 actuates fluid valve 57 to permit fluid at low pressure to pass through inlet orifice 25 into the cavity formed by the tire band 24 and mold sections 3 and 4. Upper mold section 3 continues to descend as pressure enters the tire and as follow-up pressure is maintained by molding rings 14 and 15 against the inner surface of the beads of the tire. A light pressure is maintained by upper ring 15 against the tire bead because of the force of upper mold 3 pushing the tire bead against that ring pushes the piston casing 17 against

the back pressure of the fluid in cylinder 23. Ring 14 is held lightly against the tire by the positive action of cylinder 22 in response to the controls of the invention.

Upper mold section 3 continues downward axial movement until it contacts mold section 4 (Fig. 5). Thereupon, cam 48 contacts and actuates limit switch 52, starting a timer for the vulcanizing operation and de-energizing valve 57 and energizing valve 56 to introduce vulcanizing fluid such as steam under pressure into the tire. Full molding pressure is applied to the beads by rings 14 and 15 as solenoids 61 and 60 actuate cylinders 22 and 23 in response to valve 54. Full pressure in these cylinders draws forming rings 14 and 15 axially against the tire beads 41 and 40, with full positive molding pressure. As described curing rings 14 and 15 had exterted only light pressure against the beads of the tire as the press was closing to permit rotation of those beads as the tire was expanding. The positive pressure exerted by the rings after the mold is closed serves to form the contour of the bead to accurate dimensions. Simultaneously with the exertion of full molding pressure by the bead rings 14 and 15 against the tire bead, the internal fluid pressure forces the tire against the molding surfaces of the tire cavity. The fluid pressure in the preferred form of the invention is, on the order of 170 lbs. psi or higher, steam or super-heated water at the temperature of approximately 350°F.

Depending upon the size of tire being vulcanized, the internal fluid pressure and the pressure of the bead rings will be maintained for the length of time necessary to complete the vulcanization cycle. An example of the cycle for a passenger car tire is about 15 min. at a temperature of approximately 350°F. At the end of the 15 min. period, the super-heated water or steam is blown out of the tire, and the tire is allowed to cool and then withdrawn from the mold. The cure time of 15 min. may be compared with a cure time of approximately 21 min. when the same size tire is cured with a curing bladder disposed between the source of heat in the fluid and the inner surface of the tire.

At the end of the time cycle, the pressure inside the tire is reduced to atmospheric pressure, although the bead forming rings still exert full pressure against the beads. This change of pressure can be obtained by the control cycle and the use of conventional timers to actuate switches to open valves to permit the escape of fluid to reduce the internal pressure. Also air may be blown through the tire cavity to exhaust any lingering steam or water.

Referring again to Fig. 1, the upper mold section 3 is raised axially with respect to lower mold section 4, by rotation of gear wheel 10, which pivots pressure links 9 to raised platen 7 and the upper mold section 2 vertically. When upper mold section 3 reaches the position shown in Fig. 6 the pressure inside the tire is atmospheric and, because cam 48 has released switch 52, full fluid pressure passes through valve 54 so that the cylinders 22 and 23 move bead molding rings 14 and 15 axially to release the tire beads . Simultaneously, valves 59 and 60 are denergized to allow cylinders 22′ and 23′ to actuate racks 20 and 21, thereby rotating piston rod housing 16 and 17 to contract the bead rings radially.

Rotation of gear 10 continues until the mold reaches the fully open position whereupon switch 50 actuates switch 70 to in turn actuate cylinder 22′ to extend rack 20, rotating pinion 18 to expand radially molding 14. The upper molding ring remains in the position shown in Fig. 6. When the lower ring 14 has reached the expanded position shown in dotted lines in Fig. 6, valve 53 actuates solenoid 61 to initiate operation of cylinder 22, to extend piston casing 16. This action raises the lower molding ring 14 against the upper bead of the tire 40. The tire thus is raised from the cavity of lower mold section 4 to the position shown at A (Fig. 6) and removed by the operator. Ring 14 may then be contracted and returned to its original position (Fig. 2) by actuation of the motor control switch 49. It will be seen by this description of the invention that the tire is shaped and vulcanized without the use of any member between the internal curing fluid and the surface of the tire.

WHAT WE CLAIM IS:

1. Apparatus for molding and vulcanizing a vehicle tire comprising at least two relatively movable mold sections forming a tire defining cavity, radially expansible and contractable tire bead molding means spaced between said mold sections for clamping the beads of the tire against the bead molding surfaces of the mold sections, means to radially expand said bead molding means to bring them into contact with the inner bead surfaces of the tire, and for moving them axially with respect to and in timed relation with the movement of said relatively movable mold sections, said bead molding means comprising upper and lower segmented bead clamping rings, the segments of which are radially expansible and contractable in the same horizontal plane.

2. Apparatus according to claim 1, wherein the bead molding means extends and clamps the tire bead during vucanization but retracts to permit removal of the tire after vulcanization.

3. Apparatus according to claim 1 or 2, wherein the bead molding means loosely clamps the tire bead to the surface of the

mold as it closes and applies increased clamping and molding pressure to the beads after the mold is closed and during vulcanization of the tire.

4. Apparatus according to any one of the preceding claims, wherein the mold sections are adapted for axially aligned movement with respect to each other and the bead molding rings are aligned coaxially with the mold sections and with each other.

5. Apparatus according to any one of the preceding claims, wherein the means for radially retracting and expanding each bead molding ring comprising a piston mounting a pinion and a rack actuated by a cylinder to rotate said piston, the ring being responsive in radial position to rotation of said axle.

6. Apparatus according to any one of the preceding claims, wherein hot fluid is applied, internally of the mold against the inner wall surface of the tire.

7. Apparatus according to any one of the preceding claims, including means for introducing fluid under low pressure into the tire as said mold sections move toward each other to radially expand and shape the tire, means for introducing fluid under high pressure into said tire after said mold sections are in abutting tire-defining relation.

8. Apparatus according to claim 6 or 7, wherein means are provided for moving said bead molding means axially with respect to the mold sections when the sections abut whereby as the tire is shaped the beads are lightly but positively held by the molding means and fluid under low pressure is maintained in the tire.

9. Apparatus for molding vulcanizing a vehicle tire substantially as hereinbefore described and as illustrated in the accompany drawings.

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Chartered Patent Agents.

Agents for the Applicants.

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3 SHEETS

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SHEET 1

FIG.1

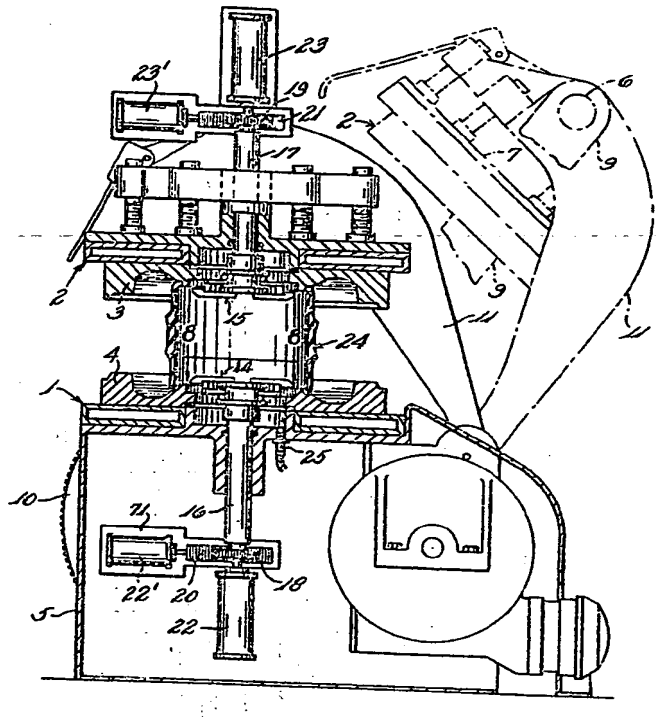
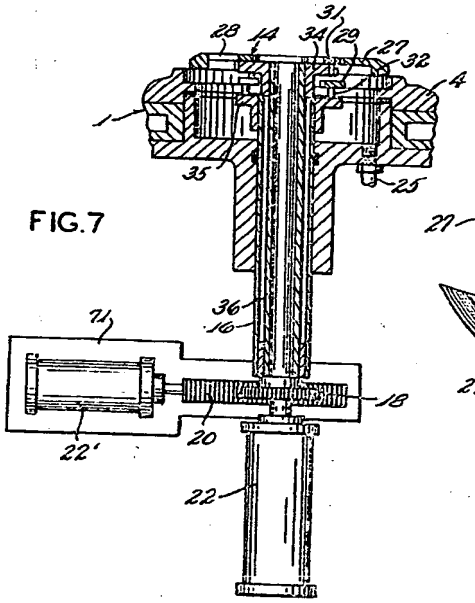


FIG.7



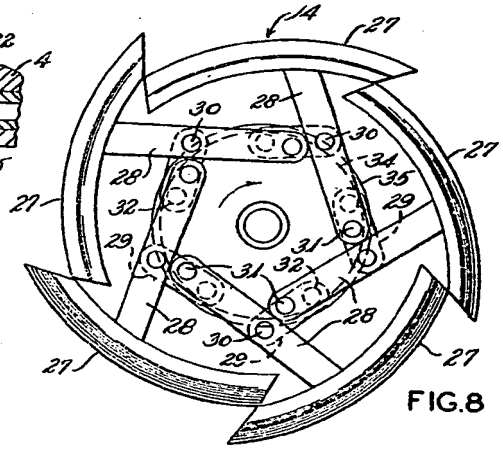


FIG.8

FIG.2

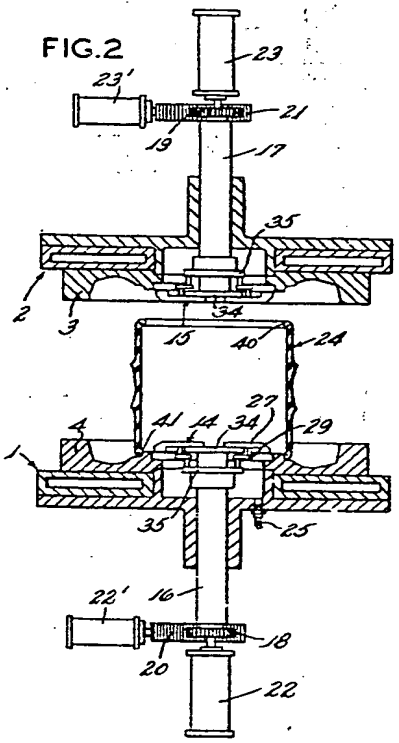
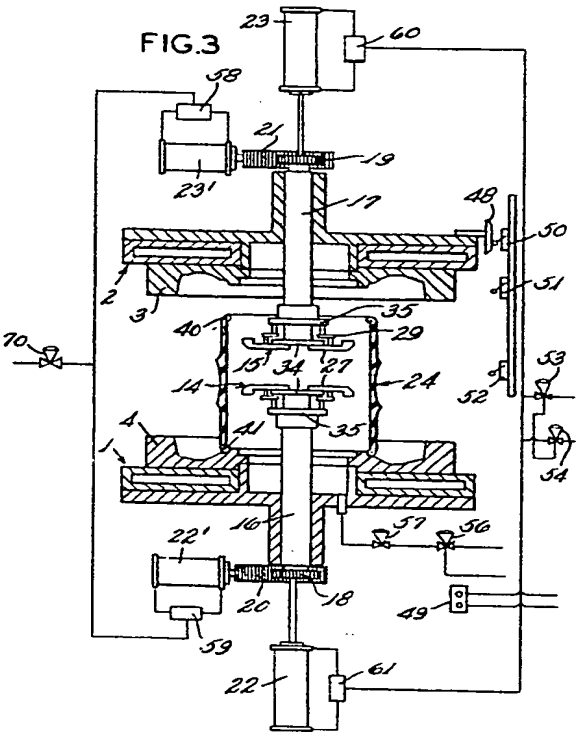


FIG.3



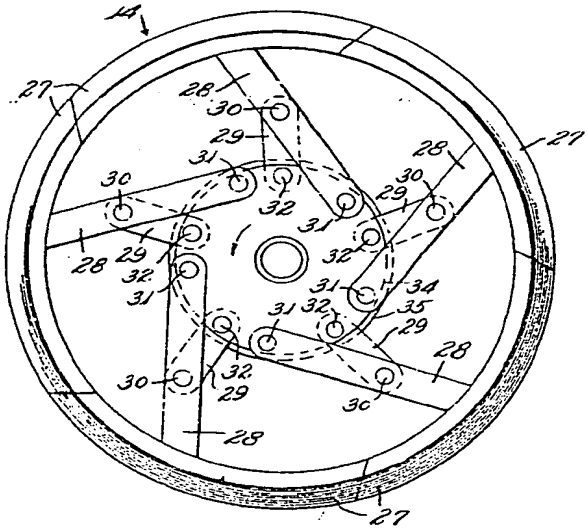


FIG.9

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SHEETS 2 & 3

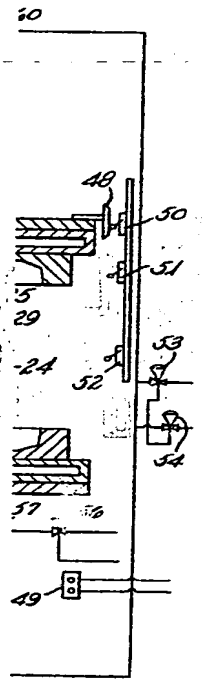


FIG. 4

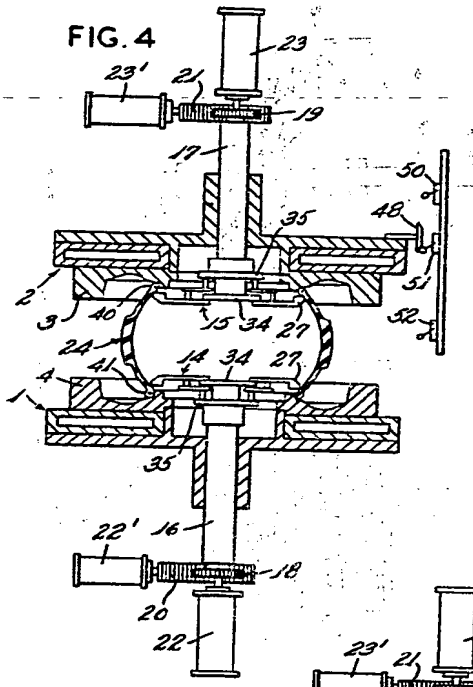
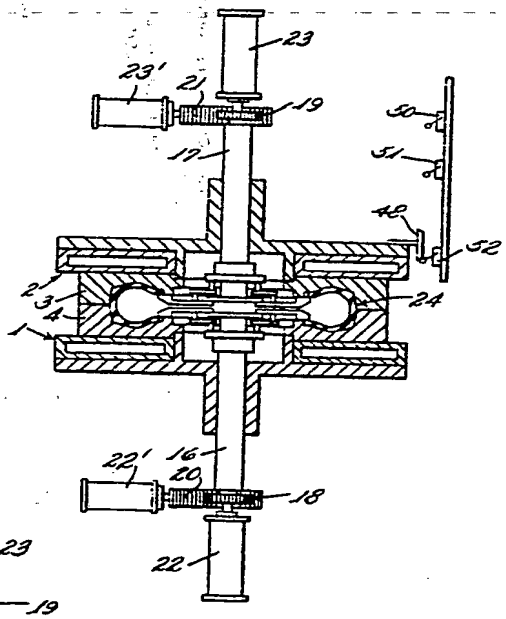
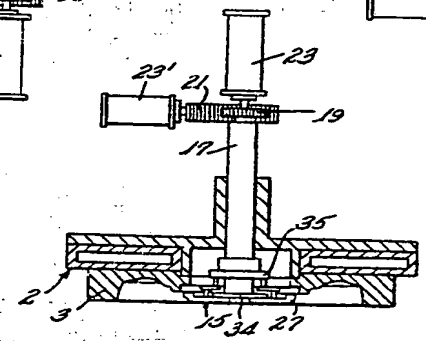


FIG. 5





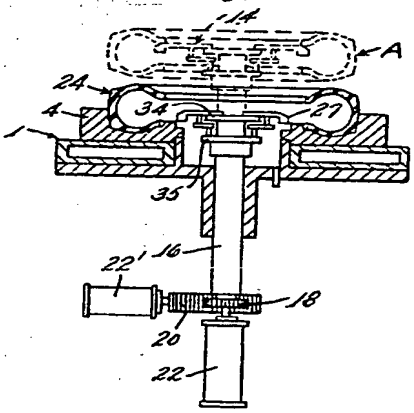


FIG. 6

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SHEETS 2 & 3

FIG.2

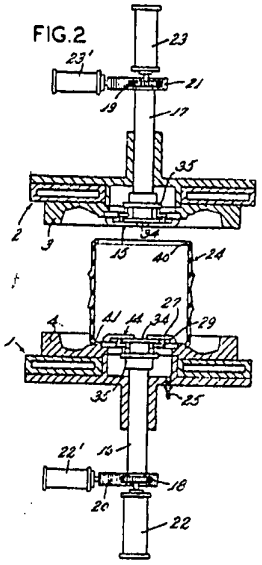


FIG.3

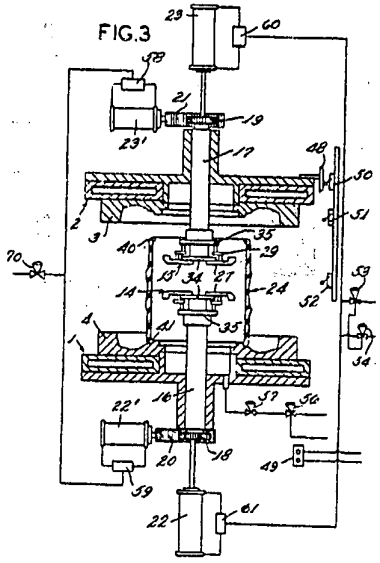


FIG.4

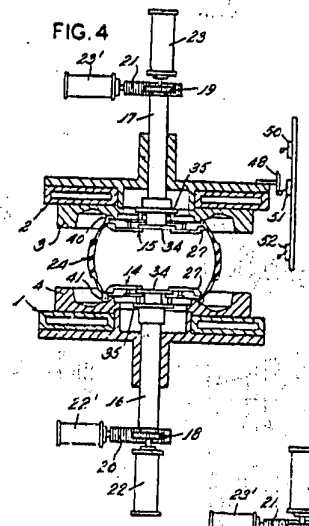
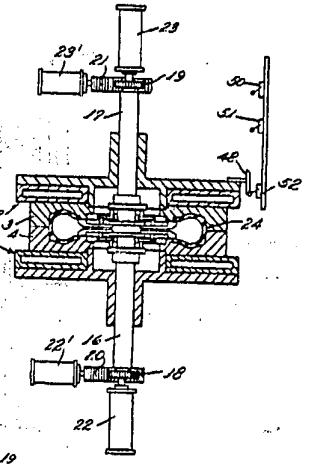


FIG.5



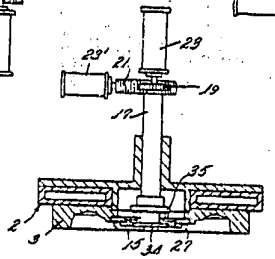
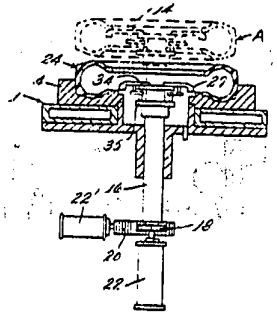


FIG.6



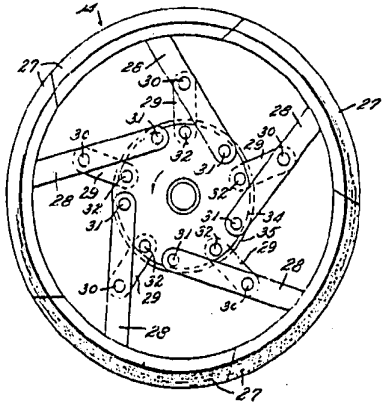


FIG.9